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(54) ELECTROMAGNETICALLY DRIVEN PUMPS

(71) I, ALAN JOHN WALKER, a British Subject of 3 Argyle Street, Dornoch, Sutherland, Scotland, formerly of 387 Maidstone Road, Gillingham, Kent ME8 0HX, do hereby declare the invention, for which I pray that a patent may be granted to me, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The invention relates to electromagnetically driven pumps and more particularly to the known class of pump in which a pumping impeller and a magnetic rotor are integrated as a unit (the magnetic part being of generally spherical profile) which unit is borne by a spherical bearing to rotate in its casing, see for example U.K. Specification No. 1207621. Such pumps are particularly useful when it is required that the rotor unit is completely sealed without rotary glands or the like, for example for pumping chemically active, sludgy, polluted, noxious, or highly flammable liquids; or for fluids which are under high pressure or vacuum; for liquids with abrasive suspensions, or in circumstances with similar problems. In some known designs the rotor unit of such pumps have been driven by a rotating magnetic system constituting part of a magnetic coupling, and in others the magnetic rotor has been the armature of a motor having a fixed stator. The present invention is applicable to either class of machine. Moreover although it is primarily applicable to a pump of the centrifugal kind, it may apply to an axial, or combined axial-centrifugal, or a radial-flow type analagous to a Lungström turbine.

In previous designs the spherical bearing has been supported by the casing by a cantilever arm or strut anchored in the casing to that side of the rotor unit which is opposite to the intake side, i.e. the side through which the fluid is admitted. It has been realised that in some applications it is advantageous to anchor the bearing to the casing on the intake side, and have it exposed to the pumped fluid. In the case particularly of centrifugal machines, the intake through the casing is substantially coaxial with the rotor (when running normally) and in such case the bearing arm is, preferably, arranged coaxially with the casing intake and passes, similarly coaxially, through the eye of the impeller. The spherical bearing which it supports is then located approximately in the plane of rotation between the impeller itself and the magnetic rotor.

According to the invention, an electromagnetically driven pump is provided comprising:

a pump casing having, a central axis, first and second walls constituting opposite ends of the casing, the second wall being an area of revolution about the central axis and of substantially non-magnetic material, a fluid inlet situated in the first wall and coaxial with the central axis, and a fluid outlet;

a bearing structure rigid with the first wall and extending within the casing towards the second wall and terminating in a spherical bearing the centre of which coincides with the central axis;

a rotor unit comprising a motor armature integrated with a pump impeller, borne for free and co-axial rotation within the casing by said spherical bearing which is so arranged that fluid forces acting upon the rotor unit in the direction of the first wall are resisted by the spherical bearing;

a magnetic system, external to the casing and adjacent said second wall and for producing a magnetic field rotating about the said central axis, whereby the rotor unit is influenced to rotate by the magnetic field which penetrates the second wall to cooperate with the motor armature.

It is further a feature that the spherical

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bearing in such a machine has its stationary part (e.g. the ball or ball-support) and its supporting structure so arranged that, by virtue of elasticity afforded by the construction of the structure, the bearing has resilience in a radial direction; this accommodates temporary or even permanent out-of-balance of the rotor unit; and may be especially useful if the liquid pumped may carry solids which could at least temporarily obstruct discharge from the impeller and itself constitute an unbalanced mass.

The said bearing structure may conveniently be attached to and extend through the fluid inlet of the first wall and through the intake eye of the impeller which is of centrifugal type. Such a structure may be elastic; for example it may be a tripod structure, attached rigidly at its inner end to the stationary bearing part (e.g. the ball) and at its outer end to the casing intake, the structure being of openwork nature forming practically no obstruction to flow into the casing; and near the bearing there may be a fairing to direct the fluid with a radial vector through the impeller eye.

In operation, the magnetic rotor may be attracted axially towards the magnetic system, thus moving away from the spherical bearing. Such magnetic attraction would, in normal use, be adequately countered by the hydraulic forces acting on the rotor and urging it towards the inlet and the spherical bearing. However, should the magnetic force become predominant, further bearing means may be provided which engage with the rotor should it lift off its spherical bearing.

Such further bearing means may, for example comprise a fixed finger-like member anchored in the concave wall of the casing and extending therefrom axially into the rotor unit, with radial clearance, to the locality of the bearing so as to form a stop in an axial sense of rotor movement.

There are now described in detail examples of machines embodying the invention which are illustrated by the accompanying drawings in which:

Figure 1 shows an arrangement in which the magnetic rotor unit is supported in operation by a spherical body, e.g. a ball, which is mounted in the suction inlet of the pump casing;

Figure 2 shows an embodiment in which the magnetic rotor is driven by a rotating magnet.

Figure 1 shows a pump-motor-set, in which a magnetic rotor comprises an impeller 1 which forms a single unit in conjunction with an armature 2. The surface of the armature facing a non-magnetic, separating wall 3, is spherical. A stator is arranged behind the wall 3, which stator consists of pole pieces 4, coils 5 and a pole bridging piece 6. A ball 7 is firmly attached to the magnetic rotor. The ball 7 is carried in a concave bearing cup 8. This cup 8 is firmly attached by a tube 9 to the pump casing 10. In operation, the impeller 1 generates a hydraulic force in the direction of arrow 11, whilst, during the starting period, the armature 2 is urged by magnetic forces in the direction of the arrow 12. Axial movement of the rotor in this latter direction is resisted by the pin 13. As soon as the hydraulic forces are larger than the magnetic forces, the ball 7 shifts away from the pin 13 and into the concave bearing cup 8.

Figure 2 shows a modified embodiment in which the rotor comprises an impeller 1 which forms a single unit with an armature 32 of magnetic material. A spherical surface is approximated by a series of permanent magnet rings such as 30 and 30′ with diameters diminishing in steps, which rings 30, 30′ co-operate with further permanent magnet rings, such as 34, situated externally thereto in spaced relationship separated therefrom by a wall 3 of non-magnetic material. The external rings 34 are carried by an armature 50, mounted for rotation on bearings 35. Armature 50, also bears a ring 41 of soft iron, slotted to carry therein conductor rods 42, the respective ends of which are electrically joined by copper rings 43 and 43′, thus constituting the armature of an induction motor. A stator, comprising pole pieces 51, windings 38, and a pole bridging ring 36, co-operates with armature 50 and causes it to rotate when coils 38 are suitably energised, thus rotating permanent magnet rings 34 and causing rings 30, 30′ and the magnetic rotor (1, 32) to also rotate due to the magnetic coupling between rings 34 and rings 30, 30′.

Armature 32 and impeller 1 have a central and spherical bearing cup 44 which mates with a ball 45 which is in turn supported by a further and fixed bearing cup 46 mounted on a pillar 47 extending axially from pump casing 10.

In order to prevent the impeller 1 and armature 32 from moving to the left (as viewed in Figure 3), opposing magnets 48, 49, and 48′, 49′, are provided which urge the rotor assembly in the direction of arrow 11.

It will be noted that motor armature 50 is separated from its co-operating stator by radial and axial air gaps 39 and 40 respectively. Pole pieces 51 are provided with slots 52 in order to reduce eddy current losses.

The pillar 47 may have sufficient resilience to compensate for small out-of-balance forces of the rotor 1, 32, that may occur in operation.

WHAT I CLAIM IS:—

1. An electromagnetically driven pump comprising:

a pump casing having, a central axis, first and second walls constituting opposite ends of the casing, the second wall being an area of revolution about the central axis and of substantially non-magnetic material, a fluid inlet situated in the first wall and co-axial with the central axis, and a fluid outlet;

a bearing structure rigid with the first wall and extending within the casing towards the second wall and terminating in a spherical bearing the centre of which coincides with the central axis;

a rotor unit comprising a motor armature integrated with a pump impeller, borne for free and co-axial rotation within the casing by said spherical bearing which is so arranged that fluid forces acting upon the rotor unit in the direction of the first wall are resisted by the spherical bearing;

a magnetic system, external to the casing and adjacent said second wall and for producing a magnetic field rotating about the said central axis, whereby the rotor unit is influenced to rotate by the magnetic field which penetrates the second wall to co-operate with the motor armature.

2. A pump according to Claim 1 in which is provided further bearing means arranged to restrain movement of said rotor unit towards the second wall.

3. A pump according to Claim 1 or 2 in which the bearing structure is adapted to allow resilient movement of the spherical bearing in a direction transverse to the central axis.

4. A pump according to any preceding Claim in which the bearing structure is a strut cantilevered from the first wall in the vicinity of the fluid inlet.

5. A pump according to any preceding Claim in which the spherical bearing comprises;

a hemispherical cup borne by the bearing structure and open towards the second wall;

a ball seated for rotation within the cup;

a concave bearing surface in the rotor unit which surface mates with the ball.

6. A pump according to Claim 2 in which the further bearing means comprise magnets arranged to urge the rotor unit towards the first wall.

7. An electromagnetically driven pump substantially as described herein with reference to Figure 1.

8. An electromagnetically driven pump substantially as described herein with reference to Figure 2.

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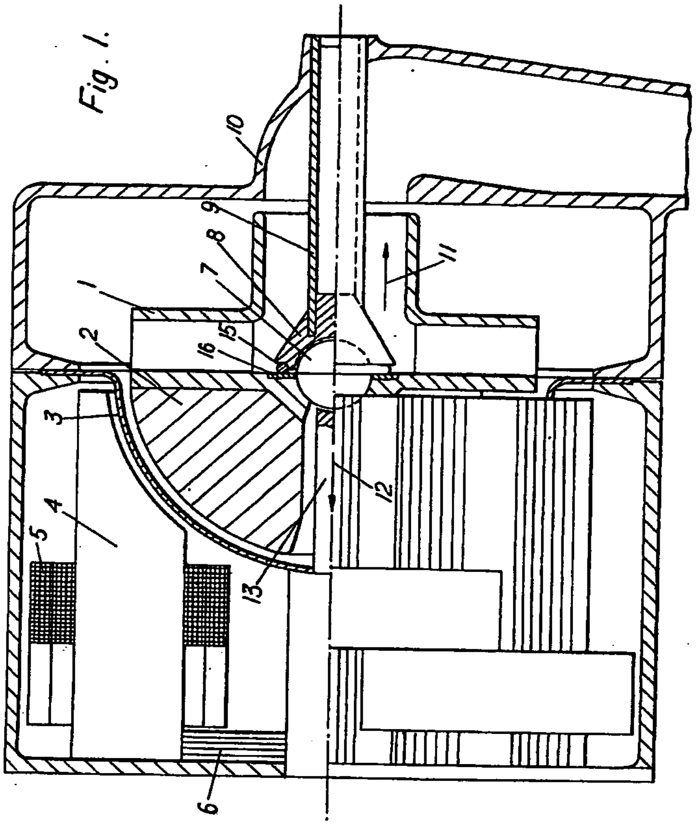
Fig. 1.



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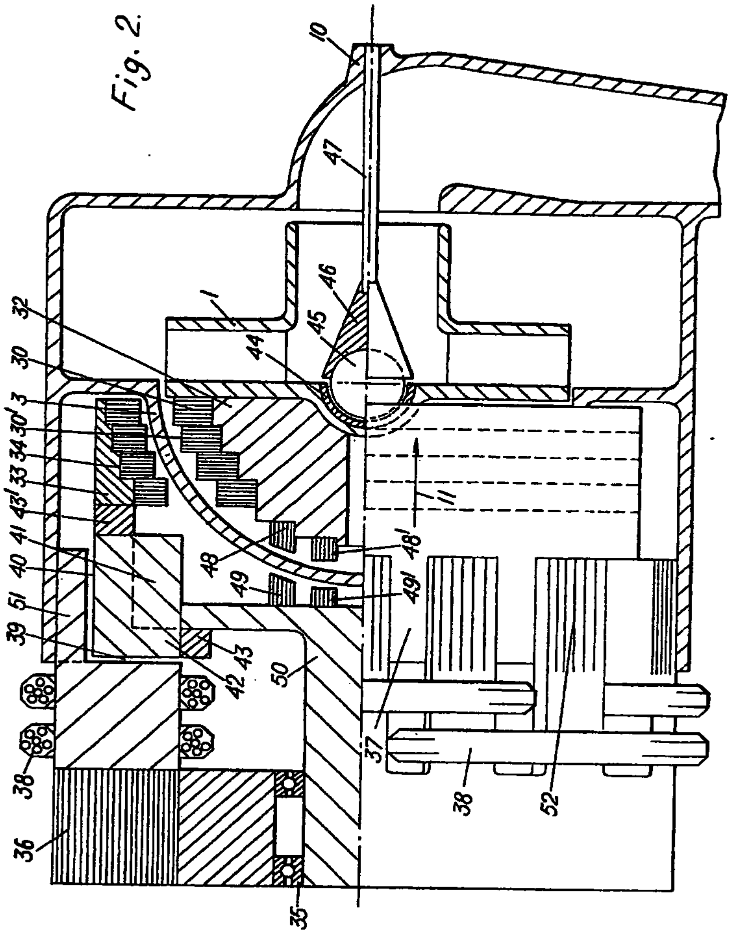
Sheet 2

Fig. 2.



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